

PATENT COOPERATION TREATY

PCT



INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY
(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)



Applicant's or agent's file reference GN-21588-PCT	FOR FURTHER ACTION See Form PCT/IPEA/416	
International application No. PCT/KR2004/000577	International filing date(day/month/year) 17 MARCH 2004 (17.03.2004)	Priority date (day/month/year) 20 MARCH 2003 (20.03.2003)
International Patent Classification (IPC) or national classification and IPC IPC7 B82B 3/00		
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<p>1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of <u>3</u> sheets, including this cover sheet.</p> <p>3. This report is also accompanied by ANNEXES, comprising:</p> <p>a. <input checked="" type="checkbox"/> (sent to the applicant and to the International Bureau) a total of <u>2</u> sheets, as follows:</p> <p style="margin-left: 40px;"><input checked="" type="checkbox"/> sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).</p> <p style="margin-left: 40px;"><input type="checkbox"/> sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.</p> <p>b. <input type="checkbox"/> (sent to the International Bureau only) a total of (indicate type and number of electronic carrier(s)) _____ containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box relating to Sequence Listing (see Section 802 of the Administrative Instructions).</p>	
<p>4. This report contains indications relating to the following items:</p> <p><input checked="" type="checkbox"/> Box No. I Basis of the report</p> <p><input type="checkbox"/> Box No. II Priority</p> <p><input type="checkbox"/> Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</p> <p><input type="checkbox"/> Box No. IV Lack of unity of invention</p> <p><input checked="" type="checkbox"/> Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</p> <p><input type="checkbox"/> Box No. VI Certain documents cited</p> <p><input type="checkbox"/> Box No. VII Certain defects in the international application</p> <p><input type="checkbox"/> Box No. VIII Certain observations on the international application</p>	

Date of submission of the demand 19 OCTOBER 2004 (19.10.2004)	Date of completion of this report 06 JULY 2005 (06.07.2005)
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INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.

PCT/KR2004/000577

Box No. 1 Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.
- ☒ This report is based on translations from the original language into the following language English which is the language of a translation furnished for the purposes of:
- ☐ international search (under Rules 12.3 and 23.1(b))
- ☒ publication of the international application (under Rule 12.4)
- ☐ international preliminary examination (under Rules 55.2 and/or 55.3)
2. With regard to the **elements** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:
- ☐ the international application as originally filed/furnished
- ☒ the description:
pages 1 - 9 as originally filed/furnished
pages* _____ received by this Authority on _____
pages* _____ received by this Authority on _____
- ☒ the claims:
pages _____ as originally filed/furnished
pages* _____ as amended (together with any statement) under Article 19
pages* 10, 11 received by this Authority on June 15, 2005
pages* _____ received by this Authority on _____
- ☒ the drawings:
pages 1/4 - 4/4 as originally filed/furnished
pages* _____ received by this Authority on _____
pages* _____ received by this Authority on _____
- ☐ the sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing.
3. ☐ The amendments have resulted in the cancellation of:
- ☐ the description, pages _____
- ☐ the claims, Nos. _____
- ☐ the drawings, sheets _____
- ☐ the sequence listing (*specify*): _____
- ☐ any table(s) related to sequence listing (*specify*): _____
4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).
- ☐ the description, pages _____
- ☐ the claims, Nos. _____
- ☐ the drawings, sheets _____
- ☐ the sequence listing (*specify*): _____
- ☐ any table(s) related to sequence listing (*specify*): _____

* If item 4 applies, some or all of those sheets may be marked "superseded."

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.

PCT/KR2004/000577

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1 - 6	YES
	Claims		NO
Inventive step (IS)	Claims	1 - 6	YES
	Claims		NO
Industrial applicability (IA)	Claims	1 - 6	YES
	Claims		NO

2. Citations and explanations (Rule 70.7)

The following documents have been considered for the purpose of this report.

D1 = JP 2001-20071 A

D2 = US 2002/165091 A1

The present invention relates to a method of massive synthesizing double walled carbon nanotubes using the vapor phase growth comprising the following steps as a main technical feature: imbedding metallic catalytic particles having a size of a few nanometer into nano-pores of a support material powder consisting of MgO, Al₂O₃, zeolite, or silica; and sintering the support material powder and synthesizing double-walled carbon nanotubes by a catalytic reaction between the catalyst metal particles and a carbon source gas, by supplying the carbon source gas to the catalyst metal particles imbedded in the support material particles.

D1 provides a method for the mass-synthesis of high purity carbon nanotubes perpendicularly arranged on a substrate by a thermochemical vapor phase deposition method.

D2 provides the metallic catalytic particles for producing single-walled carbon nanotubes. The catalytic particles contain at least one metal from Group VIII, including Co, Ni, Ru, Rh, Pd, Ir, and Pt, and at least one metal from Group VIb including Mo, W and Cr. The metal component is on a supporter such as silica.

I. Novelty and Inventive Step

Claims 1-6 provide a method of manufacturing double walled carbon nanotubes, which is different from those of manufacturing the multi-wall carbon nanotube of D1 and single-walled carbon nanotubes of D2. And none of the cited art documents teaches or suggests a step of imbedding catalyst metal particles into nano-pores of a support material powder and it is not considered to be easily invented from the invention disclosed in D1 and D2 by a person skilled in the art.

II. Industrial Applicability

There is no reason for forming a negative opinion about the industrial applicability of this invention. Consequently, claims 1-6 appear to meet the requirement of PCT Article 33(4).

What is claimed is:

1. A method of synthesizing double-walled carbon nanotubes, the method comprising:

embedding catalyst metal particles composed of Fe, Co, Ni, Mo or an alloy of the elements and having a size of 2-5 nm in nano pores of a support material powder composed of MgO, Al₂O₃, zeolite or silica;

sintering the support material powder in which the catalyst metal particles are embedded; and

forming the double-walled carbon nanotubes by supplying a carbon source gas to the catalyst metal particles embedded in the support material powder and reacting the carbon source gas with the catalyst metal particles,

wherein the embedding the catalyst metal particles in the nano pores of the support material powder comprises:

making a first solution including the catalyst metal particles;

mixing the first solution with the support material powder to form a second solution;

removing moisture included in the second solution; and

pulverizing the support material powder including the catalyst metal particles to form the support material powder in which the catalyst metal particles are supported.

2. The method of claim 1, wherein the removing the moisture is performed by a vacuum oven for 15 hours at a temperature of 150 °C.

3. The method of claim 1, wherein if the second solution is a solution containing Fe, Ni or Co, Mo, and MgO, a molar ratio of Fe, Ni or Co : Mo : MgO is 0.7-1 : 0.1-0.3 : 10-13,

if the second solution is a solution containing Fe or Ni, Mo, and MgO, a molar ratio of Fe : Ni : Mo : MgO is 0.7-1 : 0.1-0.3 : 0.1-0.3 : 10-13, and

if the second solution is a solution containing Fe or Co, Mo, and MgO, a molar ratio of Fe : Co : Mo : MgO is 0.7-1 : 0.1-0.3 : 0.1-0.3 : 10-13.

4. The method of claim 1, wherein the sintering is performed in air

atmosphere for 6-12 hours at a temperature of 700 - 900 °C.

5. The method of claim 1, wherein the forming the double-walled carbon nanotubes comprises:

5 loading the support material powder embedding the catalyst metal particles in a reactor;

maintaining the temperature of the reactor including the support material powder at 700-1100 °C; and

10 supplying a carbon source solution selected from the group consisting of alcohol, benzene, hexane, THF (tetra hydrofuran) and propanol, to an inside of the reactor in a gas form using an evaporator.

6. The method of claim 1, wherein the forming the double-walled carbon nanotubes comprises:

15 loading the support material powder embedding the catalyst metal particles in a reactor;

maintaining the temperature of the reactor including the support material powder at 700-1100 °C; and

20 supplying a carbon source gas selected from the group consisting of acetylene, methane, ethylene, propane and CO to an inside of the reactor.